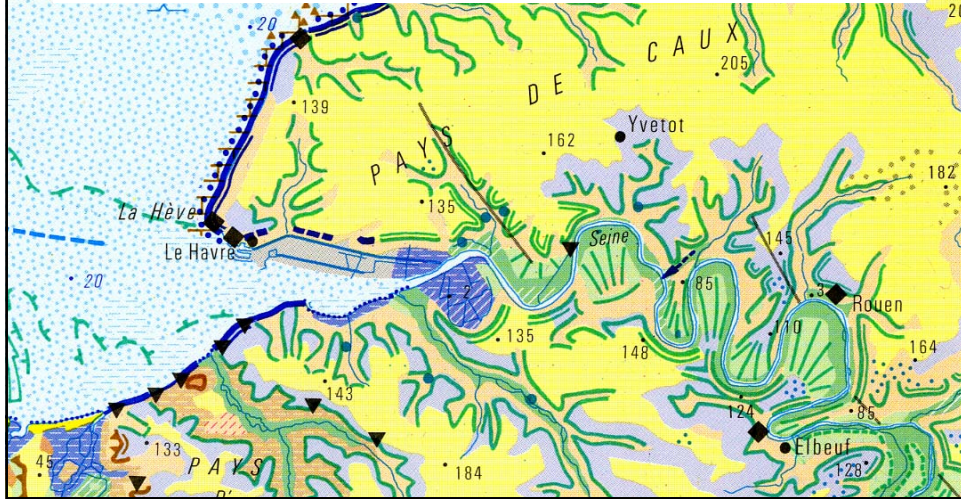


Geomorphological mapping

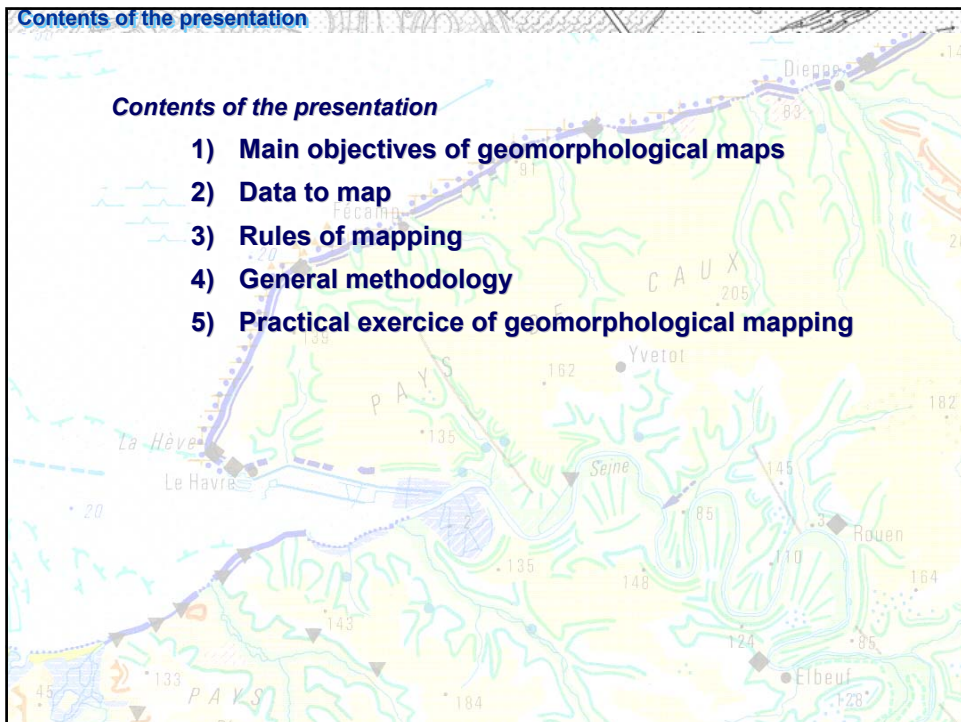
Case studies in coastal environment (beaches/rock cliffs)



Contents of the presentation

Contents of the presentation

- 1) Main objectives of geomorphological maps
- 2) Data to map
- 3) Rules of mapping
- 4) General methodology
- 5) Practical exercise of geomorphological mapping



1) Main objectives of geomorphological maps

● Geomorphological maps

- = the *most appropriate and synthetic ways* of showing the spatial distribution of :
 - landforms,
 - surface and near-surface deposits
 - processes that act on landforms
 - the time of the action of these processes

→ *better analysis and understanding of landscape development*

- = Important products of investigations made by geomorphologists on the territories

- = Usefulness to (Ahnert, 1998, Gustavsson et al., 2006, Griffiths & Abraham, 2008):
 - professionnals dealing with the landscape and landforms
 - engineers
 - urban planners
 - soils, forests scientists
 - land conservationnists
 - risks managers
 - etc.

1) Main objectives of geomorphological maps

● Geomorphological maps

- contain information on the morphology, genesis and age of landforms.
- take into account the topography and the geological structure

Geomorphological maps ~~≠~~ *Geological maps*

- can be enriched in attributes including slope, aspect, soils, climate and vegetation
- try to explain the landforms genesis

But detailed geomorphological maps are frequently considered as a time-consuming and costly activity ...

...Even if the accuracy and speed of mapping is continuously being improved by the availability of more sophisticated equipment, in particular, GPS

2) Data to map

5 different types of data

- i. Morphographic data
- ii. Morphometric data
- iii. Structural data
- iiii. Morphogenetic data
- v. Chronological data

2) Data to map

5 different types of data

- i. **Morphographic data** (purely descriptive: qualitative description or configuration of the landforms)
 - 1. *Landforms correctly identified*
 - 2. *Erosion and accumulation landforms*
- ii. **Morphometric data** (gives a quantitative description of the shapes of the landforms)
 - Slope, difference in altitude (given by contours and spot elevation e.g)*
- iii. **Structural data**
 - Relation between geological structure and landforms (selection of geological data)*
 - Distinction between hard and soft rocks, unconsolidated sediments*
 - Lithology, e.g, to show erosion resistance of the outcroppings*
- iiii. **Morphogenetic data** (to emphasize processes and conditions of landforms formation)
 - Genetic classification of landforms: Forms of denudational, fluvial, marine, glacial and periglacial, aeolian, and solution (karst) origin, polygenetic landforms*
 - Including sometime processes (gravity, main stream, wind direction, anthropological impacts, ...*
 - Detailed description of resulting deposits (in particular quaternary deposits often ignored by geological maps)*
 - The focus is on the last, or occasionally earlier, process that acted upon the land surface*
- v. **Chronological data**
 - reconstruction of the landscape history*
 - Successive generations of landforms to distinguish inherited and active landforms*

3) Rules of mapping

All the rules of mapping must, of course, be respected

The quality that any map should have is the easy readability of relevant information

► **A precise title (where, when, what ?)**

► **A structured legend (themes, sub-themes, etc.)**

- The legend must be clearly **structured** and **logical** to facilitate the overview (there is a need of classification of each data before drawing the map)
- The number of symbols must be kept low for easy use
- One geomorphological fact to map = one symbol

► **A graphic scale (rather than numerical)**

0 250 500 Mètres

~~1 / 5 000~~

► **The orientation (the North and/or geographical coordinates)**

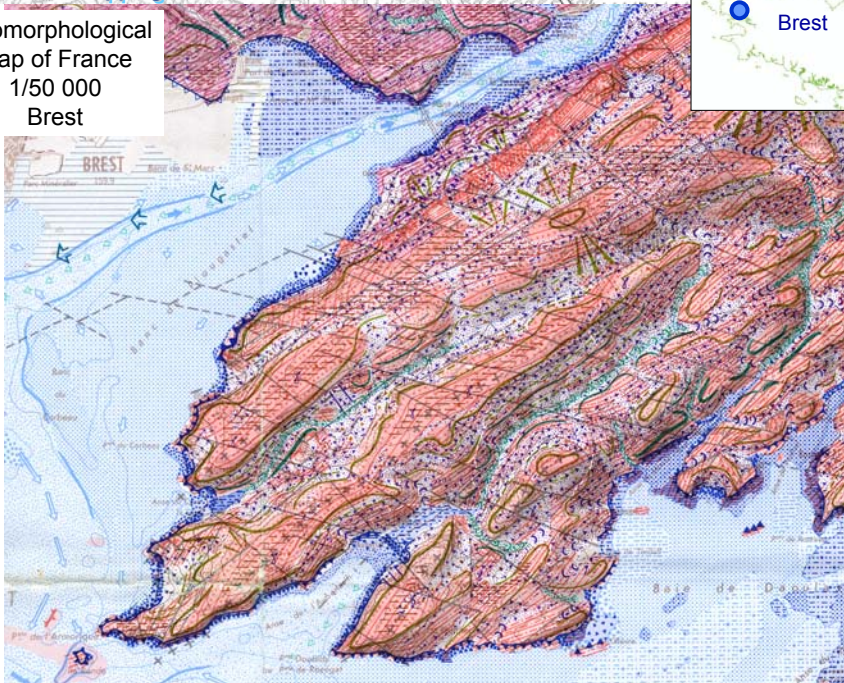
For easy orientation in the field, it is advantageous if the geomorphological map is based upon a geo-referenced topographic map or orthophotograph that shows selected infrastructure and also gives contour lines.

► **The references of data**

► **The author of the map as well as the date of realisation**

3) Rules of mapping

Geomorphological
map of France
1/50 000
Brest

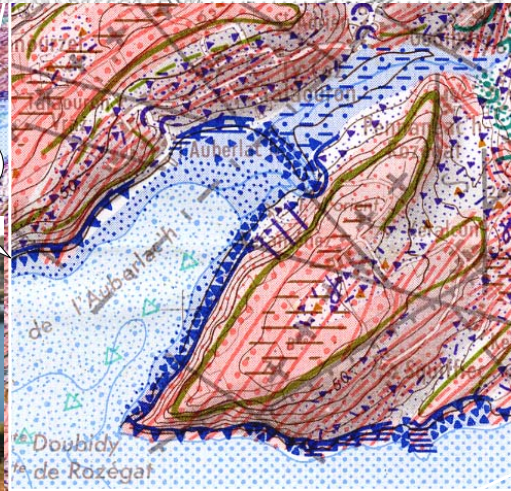


3) Rules of mapping

Geomorphological
map of France
1/50 000
Brest

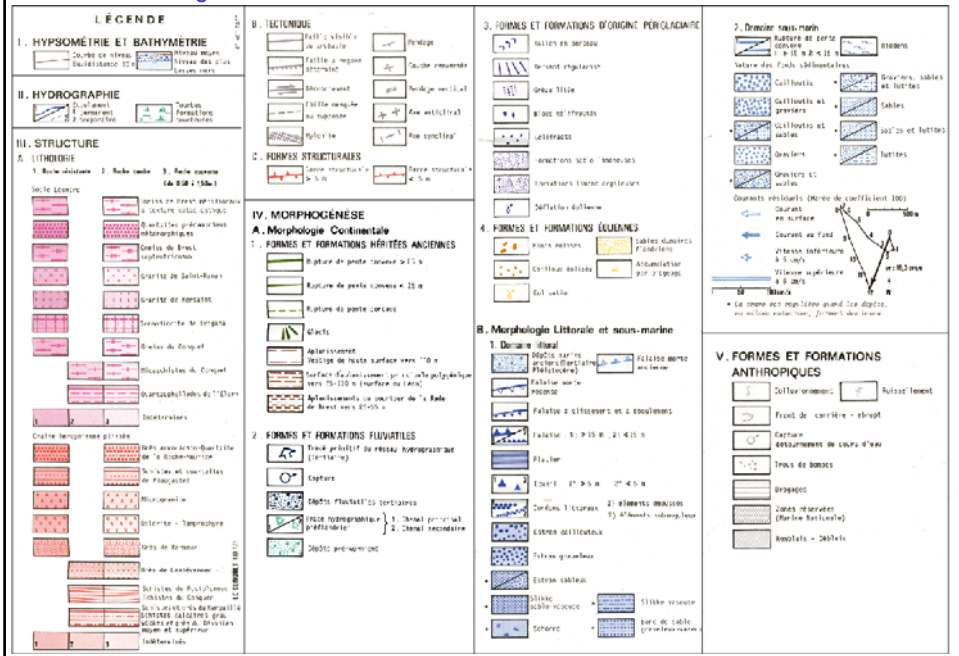


A detailed and
precise map...
but also a work of art



3) Rules of mapping

A structured legend...



3) Rules of mapping

A structured legend... Example of the French geomorphological map at 1/50 000

THEME	SUB-THEMES	MORPHODYNAMIC SYSTEM		Colours usually used in the French geomorphological map
I Morphometric data	Topography			
	Bathymetry			
II Hydrographic data	Rivers			
	Lakes			
	Glacial hydrography			
	Marine hydrography			
III Geological structures	Lithology	Inherited continental landforms and deposits (polygenetic)		
	Tectonic	Fluvial landforms and deposits		
	Structural landforms	Ground-water and karst landforms and deposits		
IV Morphogenetic data	Continental landforms	Glacial landforms and deposits		
		Periglacial landforms and deposits		
		Aeolian landforms and deposits		
		Inherited coastal and submarine landforms and accumulations		
	Coastal and submarine landforms	Present-day erosional and accumulation features		
V Bioconstruction				
VI Antropogenetic landforms				

3) Rules of mapping

A structured legend... Example of the French geomorphological map at 1/50 000

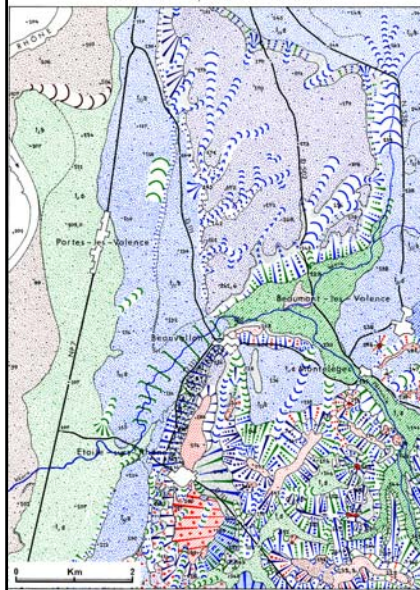
THEME	SUB-THEMES	MORPHODYNAMIC SYSTEM	PROCESSES	SYMBOLS
I Morphometric data	Topography			One fact = one symbol
	Bathymetry			
II Hydrographic data	Rivers			Polygone, line, point
	Lakes			
	Glacial hydrography			
	Marine hydrography			
III Geological structures	Lithology	Inherited continental landforms and deposits (polygenetic)		Use of specific colours
	Tectonic	Fluvial landforms and deposits		
	Structural landforms	Ground-water and karst landforms and deposits		
IV Morphogenetic data	Continental landforms	Glacial landforms and deposits	Stream flows	
		Periglacial landforms and deposits	Tidal flow	
		Aeolian landforms and deposits	Main aeolian flux	
		Inherited coastal and submarine landforms and accumulations	Direction of the longshore littoral drift	
	Coastal and submarine landforms	Present-day erosional and accumulation features	Orientation of dominant waves	
V Bioconstruction			Rates of retreat, ...	
VI Antropogenetic landforms			Etc.	

3) Rules of mapping

Adaptation of the legend when chronology is the most important fact to better understand the morphology... (river terraces)

CARTE GÉOMORPHOLOGIQUE
VALENCE 1/50000 (extrait)

CENTRE DE GÉOGRAPHIE APPLIQUÉE DE L'UNIVERSITÉ DE STRASBOURG



Lithologie

Loess Sables et calcaires molassiques Molasse

Formes et matériel

Holocène et Actuel t, t.b-t.a Würm t.b-t.a Riss t.b-t.a Mindel t_m Günz t_g Polychronique

Formes et matériel	Holocène et Actuel t, t.b-t.a	Würm t.b-t.a	Riss t.b-t.a	Mindel t _m	Günz t _g	Polychronique
Terrasse						
Glacis de dénudation						
Glacis d'accumulation						
Cône						
Formations de pente						
Vallon en berceau						
Vallon en V						
Vallon à fond plat (chenal)						
Rebord de terrasse						
Blocs						
Galets						
Cailloutis de gélifraction						
Sable						
Argile						

Composition granulométrique des terrasses

t_g : sable, gravier, galets, peu de limon

t.b et t.a : sable, gravier, galets, limon

t.b et t.a : sable, gravier, galets

t_m : sable, gravier, galets

t_w : a) terrasse à matériel régional (préalpin)

b) terrasse à matériel rhodanien

3) Rules of mapping

Adaptation of the legend when chronology is the most important fact to better understand the morphology... (river terraces)

CENTRE DE GÉOGRAPHIE APPLIQUÉE DE L'UNIVERSITÉ DE STRASBOURG

Chronology of the landforms

Change of the colours to indicate the period

Landforms related to river terraces

Other main information: granulometry and composition of the terrace deposits

Lithologie

Loess Sables et calcaires molassiques Molasse

Formes et matériel

Holocène et Actuel t, t.b-t.a Würm t.b-t.a Riss t.b-t.a Mindel t_m Günz t_g Polychronique

Formes et matériel	Holocène et Actuel t, t.b-t.a	Würm t.b-t.a	Riss t.b-t.a	Mindel t _m	Günz t _g	Polychronique
Terrasse						
Glacis de dénudation						
Glacis d'accumulation						
Cône						
Formations de pente						
Vallon en berceau						
Vallon en V						
Vallon à fond plat (chenal)						
Rebord de terrasse						
Blocs						
Galets						
Cailloutis de gélifraction						
Sable						
Argile						

Composition granulométrique des terrasses

t_g : sable, gravier, galets, peu de limon

t.b et t.a : sable, gravier, galets, limon

t.b et t.a : sable, gravier, galets

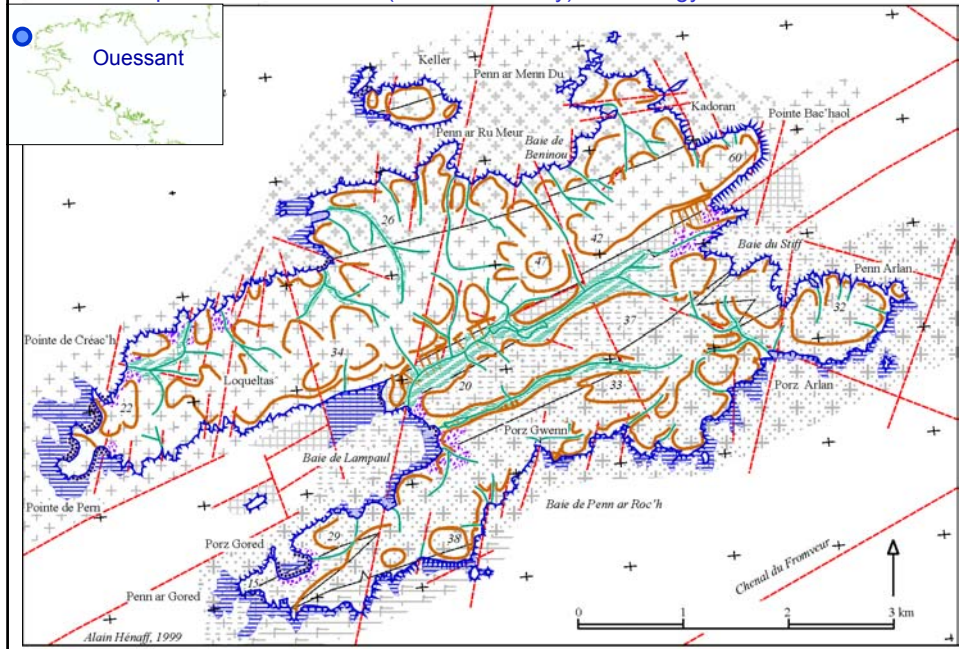
t_m : sable, gravier, galets

t_w : a) terrasse à matériel régional (préalpin)

b) terrasse à matériel rhodanien

3) Rules of mapping

Other example : Ouessant island (western Brittany) → lithology and tectonic

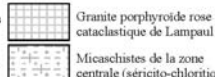
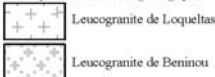


3) Rules of mapping

Other example : Ouessant island (western Brittany) 1/25 000

A - Géologie

1 - Principales formations géologiques

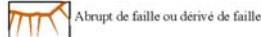
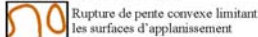


2 - Tectonique

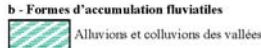
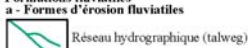


B - Modèles continentaux et littoraux

1 - Formes d'érosion polygéniques



2 - Formations fluviales

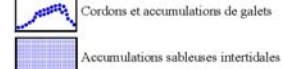


3 - Formations littorales

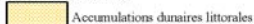
a - Formes d'érosion littorales



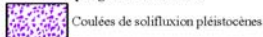
b - Formes d'accumulation littorales



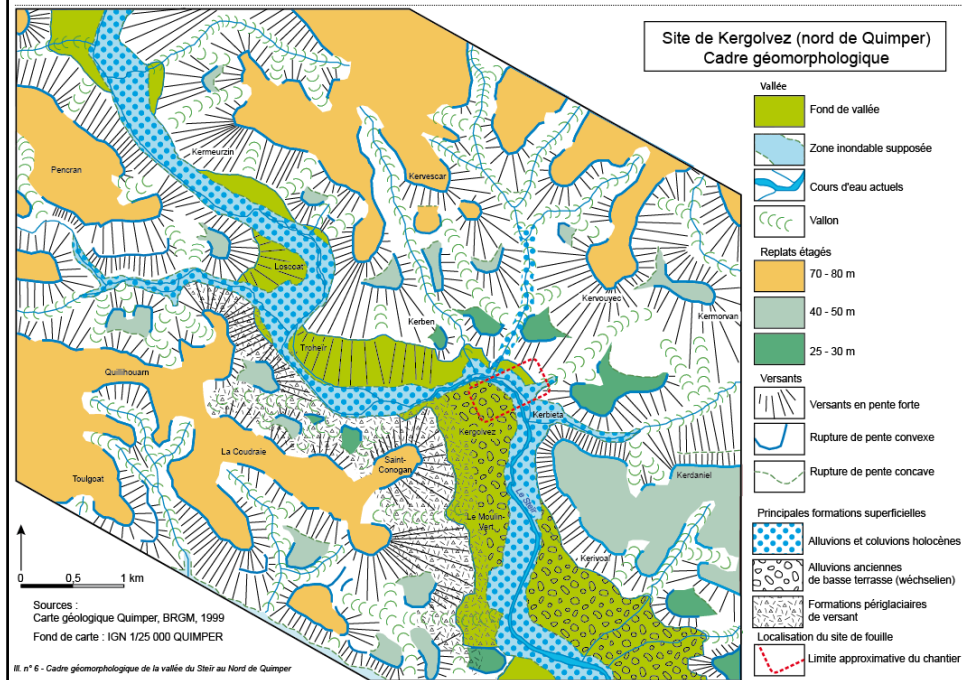
4 - Formations éoliennes



5 - Formations périglaciaires héritées



Fond de carte IGN 1:25 000 - Ile d'Ouessant, 1993
Sources : Chauris, 1966 a, 1966 b, 1992, 1994 ; Collectif, 1986 ; Collin, 1936 ; Guilcher, 1957 et travaux de terrain.



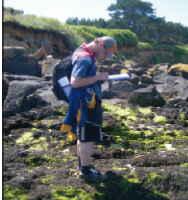



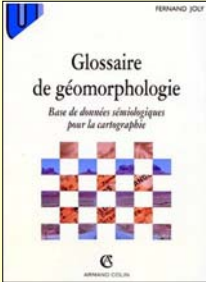
Field survey



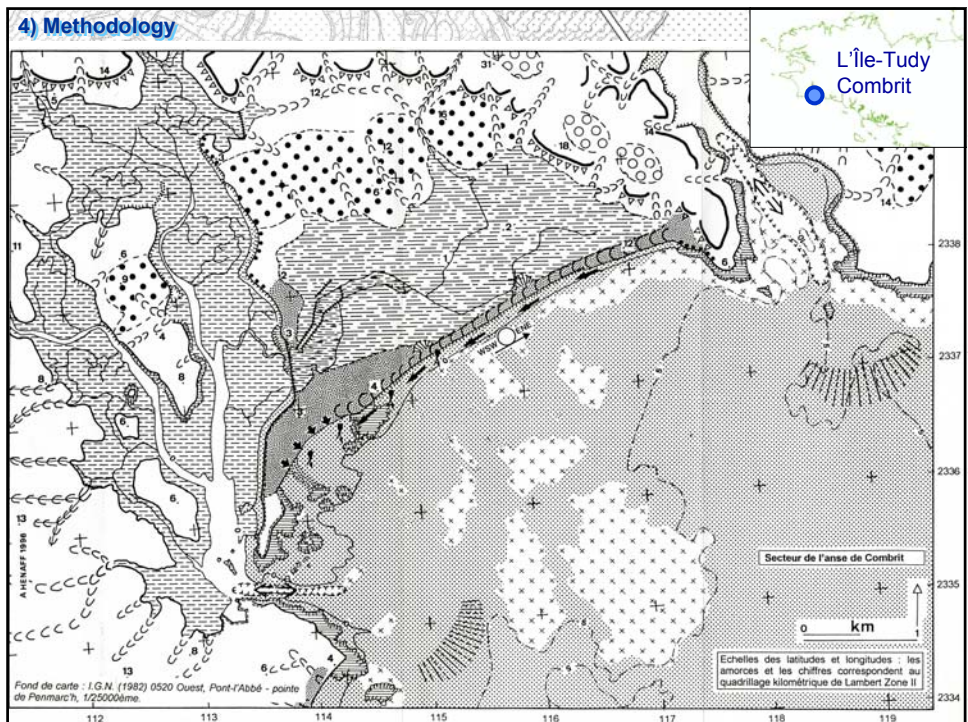
- ### Procedure
- The production of geomorphological maps starts with field survey that could be prepared with a bibliographical work
 - Field observations are recorded on a copy of the topographical map that could be enlarged for the field work
 - Aerial photographs (including satellite imagery) can enable the production of the base map.



4) Methodology

Field survey		Lab works
Observations	Legend conception	
  	<p>Bibliography</p> <p>Landforms classification</p> <p>Processes</p> <p>Age</p> <p>Symbols</p> <p>Legend structuration...</p> 	<p>1st step = Conception of the legend of the map based on field observations and remote sensing of aerial photos</p> <ul style="list-style-type: none"> -Classification of morphological features into themes, sub-themes, etc. -Present-day geomorphological processes -Lithology -Topographical data to map -etc. <p>-Choice of the symbols and colors or black and white to apply</p> <p>For example, refer to:</p> 

4) Methodology



Black and white example

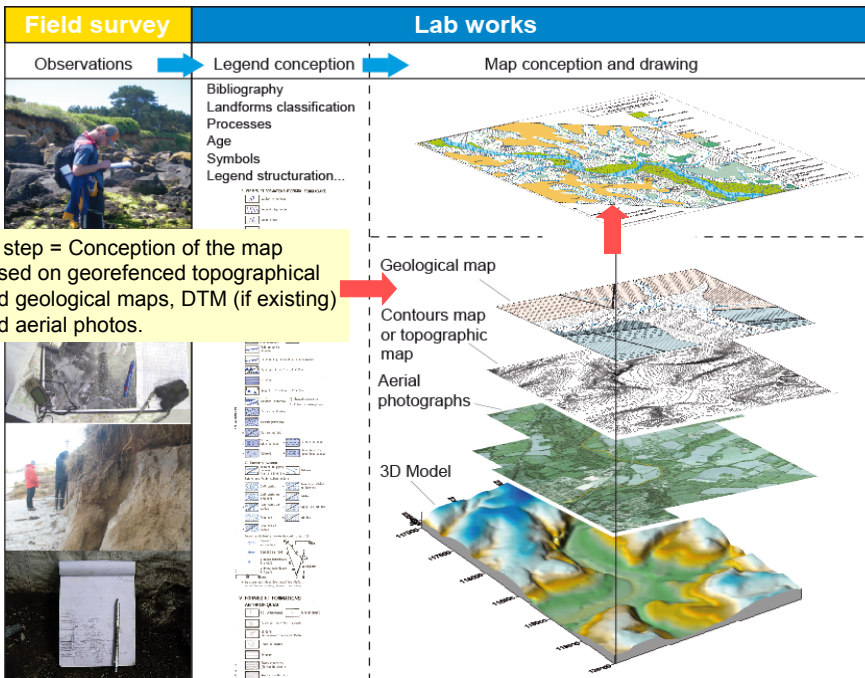
Topometric data

4) Methodology

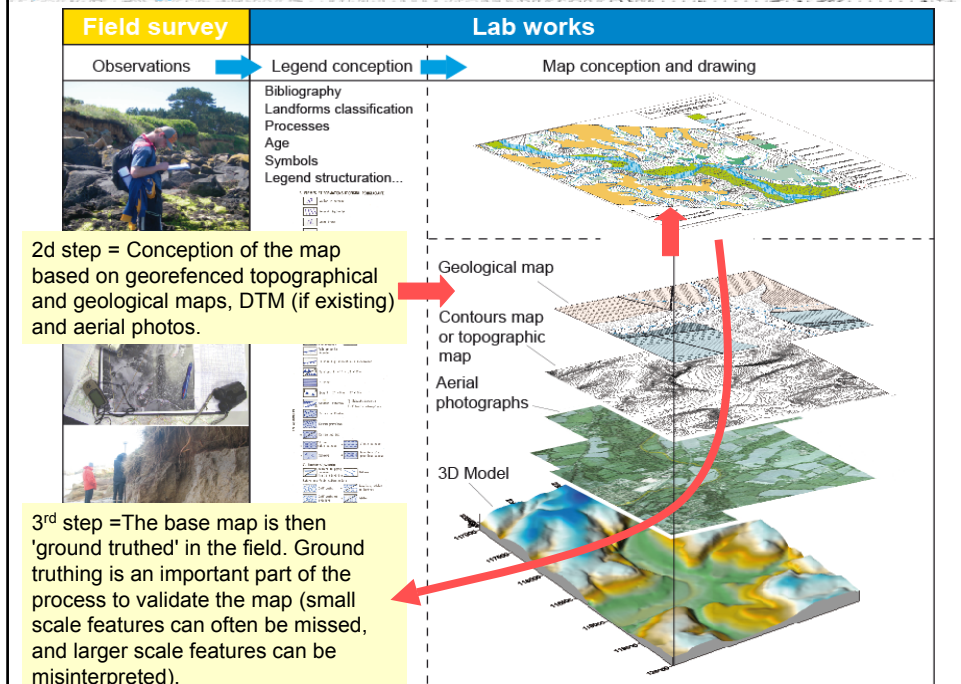
A « *simplified* » way to build the legend of a geomorphological map...

			Continental	Coastal	Sub-marine	Anthropo genetic
Landforms	Erosional	Old				
		Active				
	Deposit	Old				
		Active				
Processes	Specific					
	Not specific		aeolian	periglacial	Gravity	
Topometric data						
Lithology						

4) Methodology



4) Methodology



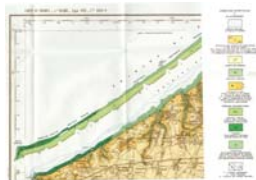
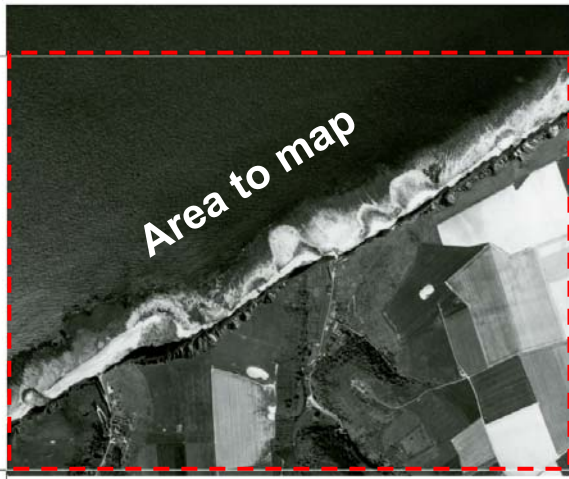
5) Practical exercise of geomorphological mapping

5) Practical exercise of geomorphological mapping

5) Practical exercise of geomorphological mapping



5) Practical exercise of geomorphological mapping



5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

- Chalk with flinty beds or nodules
- Surficial accumulation of flinty clay
- Main contours
- Spot elevation
- Bathymetric contours
- Pool of water
- Convex break of slope
- Side of incised valley
- Plateau
- V shaped hanging valley
- Scar of collapsed mass at the cliff top
- Scree of debris
- Collapsed mass due to rockslide
- Abrasion zone
- Shore platform
- Cliff top
- External cliff of the shore platform
- Tracks of old collapsed mass reshaped by coastal processes
- Pebble beach
- Collapsed mass due to rockfall
- Littoral drift
- Sands and pebbles
- Runnel (locally called "carniaux")
- Shore platform Brown algae zone
- Roads

5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

Chalk with flinty beds or nodules
 Surficial accumulation of flinty clay
 Main contours
 Spot elevation
 Bathymetric contours
 Pool of water
 Convex break of slope
 Side of incised valley
 Plateau
 Etc.
 V shaped hanging valley
 Scar of collapsed mass at the cliff top
 Scree of debris
 Collapsed mass due to rockslide
 Abrasion zone
 Shore platform
 Cliff top
 External cliff of the shore platform
 Tracks of old collapsed mass reshaped by coastal processes
 Pebble beach
 Collapsed mass due to rockfall
 Littoral drift
 Sands and pebbles
 Runnel (locally called "carniaux")
 Shore platform Brown algae zone
 Roads

2) List the main topics

Lithology
Topographic data
Hydrography
Polygenic landforms
Polygenic features due to gravity
Coastal and submarine landforms







5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

Chalk with flinty beds or nodules
 Surficial accumulation of flinty clay
 Main contours
 Spot elevation
 Bathymetric contours
 Pool of water
 Convex break of slope
 Side of incised valley
 Plateau
 Etc.
 V shaped hanging valley
 Scar of collapsed mass at the cliff top
 Scree of debris
 Collapsed mass due to rockslide
 Abrasion zone
 Shore platform
 Cliff top
 External cliff of the shore platform
 Tracks of old collapsed mass reshaped by coastal processes
 Pebble beach
 Collapsed mass due to rockfall
 Littoral drift
 Sands and pebbles
 Runnel (locally called "carniaux")
 Shore platform Brown algae zone
 Roads

2) List the main topics

3) Choose the colour

Lithology	
Topographic data	
Hydrography	
Polygenic landforms	
Polygenic features due to gravity	
Coastal and submarine landforms	








5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

Chalk with flinty beds or nodules
 Surficial accumulation of flinty clay
 Main contours
 Spot elevation
 Bathymetric contours
 Pool of water
 Convex break of slope
 Side of incised valley
 Plateau
 V shaped hanging valley
 Scar of collapsed mass at the cliff top
 Scree of debris
 Collapsed mass due to rockslide
 Abrasion zone
 Shore platform
 Cliff top
 External cliff of the shore platform
 Tracks of old collapsed mass reshaped by coastal processes
 Pebble beach
 Collapsed mass due to rockfall
 Littoral drift
 Sands and pebbles
 Runnel (locally called "carniaux")
 Shore platform Brown algae zone
 Roads

2) List the main topics

3) Choose the colour

	Lithology	
	Topographic data	
	Hydrography	
	Polygenic landforms	
	Polygenic features due to gravity	
		
	Coastal and submarine landforms	

4) Separate erosional features from accumulations

5) Practical exercise of geomorphological mapping

Lithology	Chalk with flinty beds or nodules Surficial accumulation of flinty clay	
Topographic data	Main contours Spot elevation Bathymetric contours Roads	
Hydrography	Pool of water	
Polygenic landforms	Erosional features	Plateau Convex break of slope V shaped hanging valley Side of incised valley
Polygenic features due to gravity	Erosional features	Scar of collapsed mass at the cliff top
	Accumulations	Scree of debris Collapsed mass due to rockslide Collapsed mass due to rockfall
Coastal and submarine landforms	Coastal erosional features	Cliff top Shore platform Abrasion zone Shore platform Brown algae zone External cliff of the shore platform Runnel (locally called "carniaux") Tracks of old collapsed mass reshaped by coastal processes
	Coastal accumulations	Pebble beach
	Main coastal process	Littoral drift
	Submarine accumulation	Sands and pebbles







5) Practical exercise of geomorphological mapping

1) Identify and list all the facts to map, especially the geomorphological features

Chalk with flinty beds or nodules
 Surficial accumulation of flinty clay
 Main contours
 Spot elevation
 Bathymetric contours
 Pool of water
 Convex break of slope
 Side of incised valley
 Plateau
 V shaped hanging valley
 Scar of collapsed mass at the cliff top
 Scree of debris
 Collapsed mass due to rockslide
 Abrasion zone
 Shore platform
 Cliff top
 External cliff of the shore platform
 Tracks of old collapsed mass reshaped by coastal processes
 Pebble beach
 Collapsed mass due to rockfall
 Littoral drift
 Sands and pebbles
 Runnel (locally called "carniaux")
 Shore platform Brown algae zone
 Roads

2) List the main topics


























3) Choose the colour

	Lithology	
	Topographic data	
	Hydrography	
	Polygenic landforms	
	Polygenic features due to gravity	
	Coastal and submarine landforms	

4) Separate erosional features from accumulations

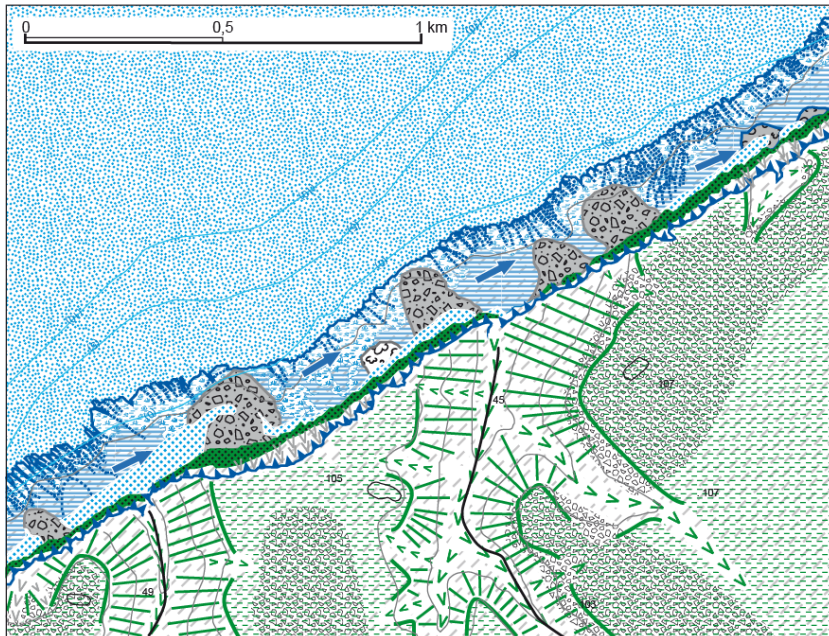
5) Choose the symbols to draw

5) Practical exercise of geomorphological mapping

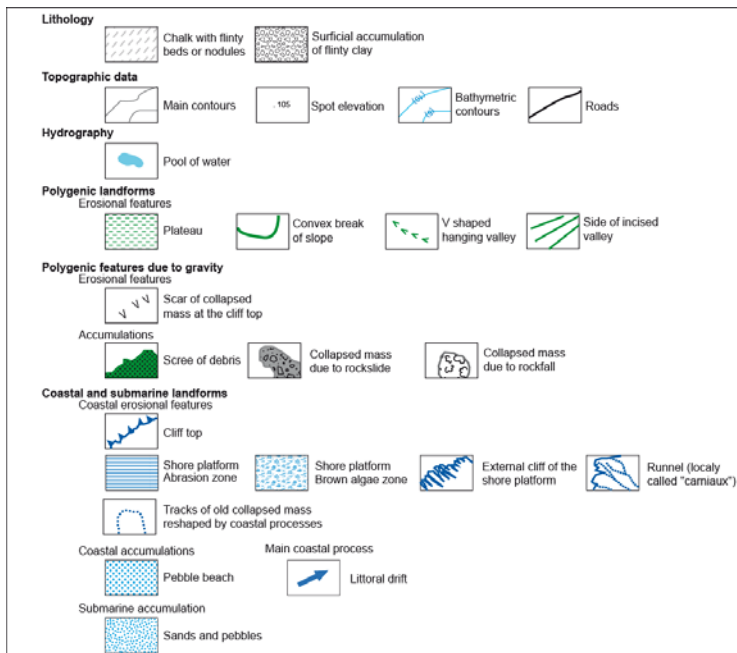
Lithology	 Chalk with flinty beds or nodules	 Surficial accumulation of flinty clay		
Topographic data	 Main contours	 Spot elevation	 Bathymetric contours	 Roads
Hydrography	 Pool of water			
Polygenic landforms				
Erosional features	 Plateau	 Convex break of slope	 V shaped hanging valley	 Side of incised valley
Polygenic features due to gravity				
Erosional features	 Scar of collapsed mass at the cliff top			
Accumulations	 Scree of debris	 Collapsed mass due to rockslide	 Collapsed mass due to rockfall	
Coastal and submarine landforms				
Coastal erosional features	 Cliff top	 Shore platform	 External cliff of the shore platform	 Runnel (locally called "carniaux")
	 Abrasion zone	 Shore platform		
	 Tracks of old collapsed mass reshaped by coastal processes			
Coastal accumulations	 Pebble beach	 Littoral drift		
Submarine accumulation	 Sands and pebbles			

5) Practical exercise of geomorphological mapping

Morphological map of the rocky coast near Senneville sur Fécamp



5) Practical exercise of geomorphological mapping



Some references :

- Carton, Coratza, Marchetti, 2005, Guidelines for geomorphological sites mapping: examples from Italy. *Géomorphologie : relief, processus, environnement*, 3, 209-218.
- Demek, J. and C. Embleton (eds) 1978, Guide to Medium-Scale Geomorphological Mapping. *Zeitschrift für Geomorphologie* Supplement band 68.
- Gustavsson, Kolstrup, Seijmonsbergen, 2006, A new symbol-and-GIS based detailed geomorphological mapping system: Renewal of a scientific discipline for understanding landscape development. *Geomorphology*, 77, 90–111
- Gustavsson, Seijmonsbergen, Kolstrup, 2008, Structure and contents of a new geomorphological GIS database linked to a geomorphological map, with an example from Liden, central Sweden. *Geomorphology* 95, 335–349.
- Guthrie R.H., 2005, *Geomorphology of Vancouver Island: Extended legends to nine thematic maps*. Research Report n° RR 02, Ministry of Environment, British Colombia, 27 p.
- Hénaff A., Lageat Y., Costa S., 2006, Geomorphology and shaping processes of chalk shore platforms of the English Channel coasts. *Zeitschrift für Geomorphologie*, supplement volume 144, p. 61-91.
- Joly F., *Glossaire de géomorphologie, base de données sémiologiques pour la cartographie*. Collection U, A. Colin, ppp
- King, R.B. 1986, Review of geomorphic description and classification in land resource surveys' in V. Gardiner (ed.) *International Geomorphology* Vol. II. (Chichester: John Wiley and Sons.), pp.384–403.

<http://geographie2001.free.fr/TDgeo.html#g%C3%A9omorphologie>